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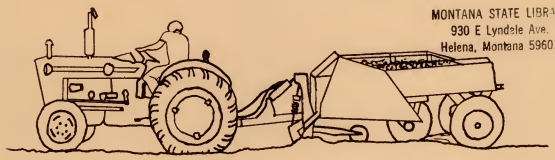

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INTRODUCTION

The formation of saline seeps is strongly correlated to the geology of the affected region (Montana, North and South Dakota, southern Alberta and Saskatchewan) and is aggravated by the crop-fallow, dryland farming system. In this region the surface soil strata are glacial sediments varying between 0 and 70 feet thick. This is underlain by a thick, impermeable marine shale formation. Excess soil water moves downward through the soil profile beyond the effective rooting zone of the agronomic crops, building up on top of the underlying impermeable shale. The excess water gradually moves downslope, accumulating in low swales or breaking out where the glacial till material is shallow. The water is strongly saline because of the inexhaustible supply of natural soluble salts contained in the subsoil, glacial till, and shale. As the moisture evaporates from the soil surface, a heavy concentration of salt is accumulated at or near the soil surface.

Soil salinity is also affecting substantial acreages of the heavy, poorly drained, irrigated soils along the major river drainages and irrigation projects.

An estimated 170,000 acres of Montana's prime agricultural land has been removed from production by saline seeps. Without some change in dryland agriculture techniques, saline seeps will continue to increase at the present 10%-per-year rate.

The basic solution to this problem is to eliminate the recharge moisture that is lost beyond the effective rooting zone of agronomic

crops, or intercept the contaminated subsurface water before it reaches the discharge area. Extensive research is underway by Montana State University and the Agricultural Research Service to develop new cropping techniques, new crops, and new equipment.

Once the seepage has been diminished or eliminated -- whether by means of drainage, continuous cropping, or crop management -- it is advisable to establish a perennial plant cover in the discharge area. Salt-tolerant plant materials are in demand for establishment in and around seeps to utilize soil moisture, stabilize soil, and provide competition for undesirable weedy plants that invade these sites. If salt-tolerant plants can be established in "dried-up" seeps, they will aid reclamation by utilizing soil moisture and trapping snow, thus increasing the amount of natural precipitation to dilute and leach salts downward in the soil profile. However, in some areas, salts accumulation may be too great to leach, thus necessitating some permanent, salt-tolerant plant cover to utilize as much of the excess moisture as possible, and provide competition for weedy species.

Very few forage species have been bred or selected specifically for use on saline-alkaline soils, but rather for optimum performance on the better quality soils. Most released forage varieties have been extensively tested for their adaptability to wet-salty conditions, with only limited success.

The saline seep plant materials program at the Bridger Plant Materials Center was made possible through a cooperative agreement

between the USDA Soil Conservation Service (SCS) and the Soil and Water Conservation Districts of Montana, Inc. (SWCDMI). Monies were granted to SWCDMI by the Old West Regional Commission (U.S. Dept. of Commerce) and Montana Department of State Lands. The project was initiated January 1, 1975. The objectives of the project are to develop plant materials, cultural techniques for production of seed and/or plants, techniques of establishing plant materials, and field testing of promising plant materials for reclamation of saline, alkaline, and saline-alkaline affected lands.

METHODS AND PROCEDURES

The SWCDMI plant materials program involves two basic approaches to the establishment of plants in saline-alkaline soils: by establishment from seed (Initial Evaluation Plantings), and by establishment from root and rhizome material (Sprigging Trials).

Initial Evaluation Plantings

The source of seed of new plant accessions is primarily from SCS plant materials centers, the USDA Agricultural Research Service, universities, and collections from native halophyte communities in Montana and Wyoming. Foreign plant materials are received via the National Plant Materials Center at Beltsville, Maryland, and Plant Introduction Stations at Ames, Iowa; Geneva, New York; and Pullman, Washington.

All accessions are seeded in initial evaluation rows in both a saline-alkaline soil and a control soil. Five grams (1/6 ounce) of

seed of each accession are planted in individual 5-meter (16.5 feet) rows at a depth of approximately 1 centimeter (1/3 inch). Each accession is periodically examined for time of emergence, seedling vigor, stand, ability to spread, seed production, foliage production, and survival.

Comparative Performance Trials

Accessions that show promise in the Initial Evaluation Planting must be further compared with released varieties of the same species or similar species that serve the same purpose. Trials have been established to compare seven tall wheatgrasses *Agropyron elongatum* ('Largo,' 'Jose,' 'Orbit,' 'Alkar,' 'Platte,' PI-368851, and PI-297871) and three beardless wildryes *Elymus triticoides* (P-15594, P-2741, and C-77). Twenty grams (.7 ounces) of each were planted in individual 20-meter (66 feet) rows across a known salt concentration gradient. A similar trial established in March 1976 was removed because of the invalid results created by unforeseen variations in the salt concentration.

Initial Seed Increase

Once an accession has shown some superiority in the Initial Evaluation Planting, it is established in longer rows for seed increase purposes. Four perennial grass accessions have been established in 23-meter (75 feet) rows in slightly saline soils. These accessions are WY-577 *Sporobolus airoides*, WY-573 *Poa arida*, M-1032 *Agropyron smithii*, and M-1030 *Agropyron trachycaulum*. Additional

seed of NM-184 *Sporobolus airoides* and C-77 *Elymus triticoides* has been received from the Los Lunas PMC, and seed of 'Prairieland' Altai wildrye *Elymus angustus* requested from the Swift Current, Saskatchewan Research Station.

Plant materials are not usually put into Initial Seed Increase until they have been evaluated for a 4- to 5-year period. However, in this program the better material is being increased after only 1 to 2 years of evaluation to accelerate the program due to time limitations.

Cultural Trials

A sprig harvester and sprig planter (figure 1) have been acquired and are being used to establish perennial vegetation in seep discharge areas. These machines were originally designed to excavate and plant rhizome material of Bermudagrass *Cynodon dactylon*, bluegrasses, *Poa* species, and zoisgrass, *Zoysia* species, in the south-central states.

Sprigging is a method of plant propagation whereby rhizome material is buried in the soil and sprouts new plants from root nodes and leaf meristem. By planting with a sprig planter, the root material is placed at a depth of approximately 10 centimeters (4 inches), usually below the higher concentration of salts near the soil surface. Theoretically, the root material has more stored reserves and is in a more advanced stage of maturity than a seed and, therefore, should have a greater chance of establishment under the severe physical and physiological conditions of a saline seep.

Five rhizomatous plant species, available in production fields at the Bridger PMC, are being tested for their susceptibility to the sprigging technique. These species are as follows: 'Garrison' creeping foxtail *Alopecurus arundinaceus*, 'Rosana' western wheatgrass *Agropyron smithii*, P-15594 beardless wildrye *Elymus triticoides*, 'Critana' thickspike wheatgrass *Agropyron dasystachyum*, and 'Lutana' cicer milkvetch *Astragalus cicer*. Preliminary trials in 1975 indicate that cicer milkvetch and thickspike wheatgrass were not conducive to propagation by sprigging.

Sprigs were planted on three separate occasions (July 2, August 8, and September 10, 1975) to determine the optimum sprigging date. The material sprigged on July 2 failed totally, while the August 8 and September 10 sprigging produced significant stands. The optimum time seems to be early September when the environmental conditions are not as severe, i.e., temperature is cooler and favorable moisture conditions exist.

Alkali cordgrass *Spartina gracilis* will be added to the list of rhizomatous species used in the sprigging trials. A native, relatively pure stand of alkali cordgrass has been located northwest of Terry, Montana.

Field Test Sites

Field test sites have been located in Montana and Wyoming with the help of SCS field personnel, Agricultural Research Service, and Montana Extension Service.

Bridger PMC

Through a cooperative agreement with the Soil Conservation Service, land has been made available to the SWCDMI saline seep plant materials project. Approximately .4 hectares (1 acre) each of a saline (Treatment) and a nonsaline (Control) site have been provided. At the PMC, seepage from an adjacent irrigation canal has created a wet, saline-alkaline soil (figure 2). These soils are typical of saline seep discharge areas (containing sodium, magnesium, and calcium salts) and have relatively high salts conductivity (8 to 30 mmhos/cm) (table 1). There is a permanent water table at 1/2 to 1 meter (20-40 inches), depending on the water level in the adjacent irrigation canal.

Hardin Site

Sprigging trials have been established on the Larry Torski farm, 6.5 kilometers (4 miles) west of Hardin, Montana. This site has severe seepage in a long natural drainage. The adjacent areas have been seeded to crested wheatgrass *Agropyron cristatum* and alfalfa *Medicago sativa*, and utilized as dryland hay and pasture (figure 3). The actual recharge area has not yet been defined, as seedings of permanent vegetation upslope from this area have failed to reduce the seepage. Perliminary soil analyses indicate the salts concentration to be quite high throughout the seeped area (table 1).

Powell Site

Replicated sprigging trials have been established on the Elmer Ratcliff farm, 8 kilometers (5 miles) west of Powell, Wyoming. This

TABLE 1. Representative soil analyses from the five field test sites. (Composite of three 0"-12" samples.)

	pH	O.M. %	Nitrate Nitrogen ppm	Phosphorus ppm	Potassium ppm	Calcium meq/100 g.	Magnesium meq/100 g.	Sodium meq/100 g.	Sulfur ppm	Bicarb. ppm	Conductivity mmhos/cm	S.A.R.	Texture Sand/Silt/Clay
Bridger	8.5	0.9		64	299	30.0	5.4	18.8			22.0	4.5	
	8.4	1.2		52	259	30.0	9.4	22.8			12.0	5.1	
	8.8	1.3		79	230	19.8	6.0	18.6			17.0	5.2	
	8.8	1.0		68	210	21.0	6.0	18.4			16.0	5.0	
Hardin	9.0	1.5	56	16	230	28.8	29.4	36.1			46.0	6.7	
	8.8	1.4	66	21	220	29.2	35.1	47.8			73.0	8.4	20/34/46
	9.1	1.4	78	16	210	30.4	18.4	52.2			59.0	10.7	20/30/50
	9.2	1.5	81	15	190	30.8	15.7	52.2			55.0	10.9	
Powell	8.5	.4	17	19	156	25.1	2.8	15.0			13.0	4.0	47/24/29
	9.0	.2	18	26	165	19.5	2.1	25.0			16.0	7.6	38/29/33
	9.0	.2	11	19	138	21.0	2.1	35.0			28.0	10.3	
	9.0	.2	18	52	211	23.0	2.3	31.0			26.0	8.7	
Ft.Benton	8.0	1.7	8	27	325	9.1	8.7	5.0	138	214	5.8	1.68	28/39/33
	8.6	2.3	47	35	275	7.9	10.3	8.3	138	193	7.3	2.75	
	8.4	2.5	35	46	325	4.5	11.3	9.7	138	290	7.9	3.45	
	8.1	2.4	50	68	325	4.9	11.3	13.2	138	232	9.1	4.63	23/70/7
Conrad	8.6	1.7	1.1	1	300	37.0	8.9	2.5	138	102	4.9	0.52	34/31/23
	8.8	1.9	2.6	3	500	35.0	10.8	7.7	138	154	6.4	1.61	
	9.4	0.9	17	9	350	35.0	23.9	19.5	138	167	18.0	3.59	
	9.4	1.2	14	1	275	40.0	25.8	16.8	138	154	12.7	2.93	50/27/23

Figure 1. Sprig planter (left) and sprig harvester (right) used to establish sprigging trials in wet-saline soils.

Figure 2. Test site located at Bridger Plant Materials Center. Seepage is from irrigation canal on the right.

Figure 3. Field test site located west of Hardin, Montana.

Figure 4. Field test site located west of Powell, Wyoming.

site has saline-alkaline soils that have been exposed by land leveling, and is perpetuated by seepage created by irrigation water loss from adjacent fields (figure 4). Sprigging could not be done across the existing salt concentration gradient because of the direction of irrigation. The sprigging trials were replicated 11 times to ensure sprigging in all portions of the gradient. The remaining portion of the field is presently planted annually to malting barley.

Highwood Bench Site

A field test site has been arranged for on the Dave Dyrland farm on the Highwood Bench south of Fort Benton, Montana. The site is a large discharge area, 2 hectares (5 acres), created by seepage from adjacent crop-fallow, stripcrop fields (figure 5). A 100-meter (330 feet) strip of alfalfa has been established on three sides of the discharge area. There is a distinct gradient going from wet-saline to dry nonsaline. Both sprigging and seeding are planned for this site in the fall of 1977 (table 2).

Conrad Site

A field test site has been acquired on the Ron Bokma farm, 5 kilometers (3 miles) northwest of Conrad, Montana. The seep discharge has removed an area 125 meters (410 feet) by 100 meters (328 feet) from agricultural production (figure 6). Adjacent summer-fallow strips have contributed to the problem. Alfalfa has been established on the north side, with barley planted on the east and west sides, and a fallow area to the south. Two areas within the

Figure 5. Field test site located on the Highwood Bench, south of Fort Benton, Montana.

Figure 6. Field test site located northwest of Conrad, Montana.

seep have sufficient salt concentration gradients. Both sprigging and seeding are planned for this fall (table 2).

TABLE 2. Proposed materials for sprigging and seeding at the Highwood Bench and Conrad Field Test Sites.

Sprigging -

Garrison	Creeping foxtail	*Alopecurus arundinaceus*
Rosana	Western wheatgrass	*Agropyron smithii*
P-15594	Beardless wildrye	*Elymus triticoides*
M-1222	Alkali cordgrass	*Spartina gracilis*

Drill Width Seeding -

Rosana	Western wheatgrass	*Agropyron smithii*
Revenue	Slender wheatgrass	*Agropyron trachycaulum*
P-15594	Beardless wildrye	*Elymus triticoides*
C-77	Beardless wildrye	*Elymus triticoides*
NM-184	Alkali sacaton	*Sporobolus airoides*
Alkar	Tall wheatgrass	*Agropyron elongatum*
Largo	Tall wheatgrass	*Agropyron elongatum*
Volga	Mammoth wildrye	*Elymus giganteus*
Prairieland	Altai wildrye	*Elymus angustus*
Vinall	Russian wildrye	*Elymus junceus*
P-15590	Basin wildrye	*Elymus cinereus*
Wytana	Fourwing saltbush	*Atriplex canescens aptera*
Kenmont	Tall fescue	*Festuca arundinacea*

5-10 Meter Row Seedings -

Twenty accessions that have had favorable performance but the seed supply is limited.

RESULTS AND DISCUSSION

Initial Evaluation Plantings

1975 Initial Evaluation Planting

Of the 247 accessions of 122 species seeded on June 11, 1975, 52 exhibited some emergence, but only 9 accessions were surviving at the end of the growing season. Those surviving included five accessions of tall wheatgrass *Agropyron elongatum* (PI-368851, PI-297871, Jose, Largo, and Orbit), CR-3 crested wheatgrass, PI-370672 Russian wildrye *Elymus junceus*, M-966 winterfat *Ceretoides lanata*, and WY-549 Siberian salttree *Halimodendron halodendron*.

An additional 20 accessions that failed to emerge during the first growing season emerged in the spring of 1976 (see appendix A). Some of the seeds may have needed additional winter stratification, while others may not have had sufficient free moisture available to germinate the first year. The better accessions were: Altai wildrye, NB-328 and 'Volga' mammoth wildrye *Elymus giganteus*, 'Sawki' and PI-314665 Russian wildrye, and 'Wytana' fourwing saltbush *Atriplex canescens* var. *aptera*.

1976 Initial Evaluation Planting

Ninety-five accessions were planted on February 2, 1976. A total of 71 accessions exhibited some emergence and 62 accessions were still surviving at the time of the first killing frost (Oct. 15, 1976). Plant densities were recorded for each accession to show increases or decreases throughout the growing season. Because of

stooling and spreading, density measurements were later converted to estimation of stand (appendix B). Several accessions have developed good, vigorous stands in saline-alkaline soils, e.g., M-1030 and M-1054 slender wheatgrass *Agropyron trachycaulum*, Altai wildrye, C-77 and P-2741 beardless wildyre, M-1032 and M-1050 western wheatgrass, NM-184 and WY-577 alkali sacaton, WY-571 plains bluegrass *Poa arida*, and WY-564 and M-997 Nuttall alkaligrass *Puccinellia airoides*.

1977 Initial Evaluation Planting

Fifty-five accessions were seeded on October 20, 1976. These accessions consisted primarily of Wyoming collections and some foreign collections (appendix C). The emergence has been extremely poor during the spring of 1977 with only ten accessions emerging. This may be a result of the drier than normal conditions of this seep area. Irrigation water may have to be applied to encourage germination and emergence.

Cultural Trials

1975 Sprigging (Bridger PMC)

The stem density of newly emerging plants was estimated once a month until stooling and rapid spread from rhizomes made it impossible to make a representative count. Stand and average between-row spread were parameters used to compare the three species (table 3). Plant development was extremely slow during the spring and early summer, but spread rapidly from the later part of July through

TABLE 3. Density of plants developing from sprigged rhizome material.

Time of Sprigging		Density/meter								% Stand		Spread (meters)	
		1975			1976								
		9/8	9/26	10/31	5/7	5/26	6/18	7/7	8/11	10/29/76	6/15/77	10/29/76	6/15/77
August 7-8	*Alopecurus arundinaceus*	1.9	1.3	1.5	2.3	2.3	3.0	4.3	13.5	55	60	.5	1.0
	Elymus triticoides	0.1	0.3	0.7	1.0	1.0	1.2	1.7	5.0	34	45	.5	1.2
	Agropyron smithii	0	0.1	0.3	0	0.5	0.5	0.5	6.1	42	45	,75	1.8
Sept. 10	*Alopecurus arundinaceus*		1.7	5.3	4.0	5.1	5.3	7.0	2.9	85	90	.60	1.0
	Elymus triticoides		0	2.7	3.6	4.2	5.3	5.3	13.0	82	100	.75	1.8
	Agropyron smithii		0.4	4.8	2.8	4.0	4.5	5.6	62.5	96	100	1.20	1.8

September. There were no obvious signs of winter injury, although the winter 1976-77 was quite mild. The developments of the sprigging trials can be clearly seen in the picture sequence (figures 7-10).

The salt conductivity of the surface 1 foot is in the moderate (4-8 mmhos/cm) to high (8-16 mmhos/cm) range. The subsurface water is only moderately saline with a conductivity of 1500 mmhos/cm. Rooting down to the cleaner water table may have aided the plant development, particularly the creeping foxtail, which is generally not considered to be very salt tolerant. Under these moderate salt conditons, 'Rosana' western wheatgrass has spread the most, followed closely by P-15594 beardless wildrye.

It is apparent that fall sprigging produces the best initial stand. The intense heat of July and August add to the stress already imposed by the saline soil conditions.

1976 Sprigging (Bridger PMC)

Sprigs of Garrison creeping foxtail, Rosana western wheatgrass, and P-15594 beardless wildrye were sprigged in the area that was previously the July 1975 sprigging site. Each species was replicated three times in 25-meter (82 feet) rows. There are salt concentration gradients in both the north-south and east-west directions. This study is designed to reveal the salt tolerance limits of the the three rhizomatous species. The salt conductivity ranges from 8 to 30 mmhos/cm.

Figure 7. Sprigging trials at Bridger PMC. Sprigs planted on July 1, 1975 (left), August 8 (center), and September 10, 1975 (right). (Photo taken November 12, 1975.)

Figure 8. The September 10 sprigging trial (right to left): creeping foxtail, blank row, beardless wildrye, and western wheatgrass. (Photo taken July 21, 1976.)

Figure 9. The September 10 sprigging trial (right to left): creeping foxtail, blank row, beardless wildrye, and western wheatgrass. (Photo taken Sept. 10, 1976.)

Figure 10. The September 10 sprigging trial (right to left): creeping foxtail, blank row, beardless wildrye, and western wheatgrass. (Photo taken April 11, 1977.)

Early density measurements indicate that there is a significant difference between the three species in their ability to establish in wet-saline soils (table 4). Beardless wildrye has developed farther along the salt gradient, establishing plants in soil with conductivity approaching 30 mmhos/cm in the surface 30 cm (1 foot) of soil. At the other extreme, creeping foxtail apparently is limited by salts in excess of 12 mmhos/cm. Western wheatgrass is intermediate between these two extremes.

TABLE 4. Establishment and density of plants developing from sprigs planted September 8, 1976.

	Density/25 meters									% Stand		
	10/12/76			11/2/76			6/13/77			6/13/77		
	Rep			Rep			Rep			Rep		
Species	I	II	III	I	II	III	I	II	III	I	II	III
P-15594[1/]	15	9	29	15	13	29	140	118	175	100	80	100
Rosana[2/]	20	13	18	24	16	20	33	25	32	67	50	60
Garrison[3/]	0	10	18	1	10	18	0	18	65	0	20	75

1/ Beardless wildrye
2/ Western wheatgrass
3/ Creeping foxtail

1976 Sprigging (Powell Site)

Because of an extremely dry fall, the Powell site was given an 8-hour irrigation on October 7. An electric fence was put up around the site to exclude livestock.

The site was examined on May 23, 1977. There were not enough plants growing to warrant making density counts. The only species that had produced any plants at all was P-15594 beardless wildrye.

The portion of the salts concentration gradient with the lowest conductivity was extremely dry at the time of sprigging and may not have gotten irrigation water soon enough. The beardless wildrye that was coming was in the wetter portion of the seep with salt conductivity in the 20-30 mmhos/cm range.

1976 Sprigging (Hardin Site)

This sprigging site was examined on June 16, 1977. The seepage had become worse, increasing the salts concentration toward the periphery of the seep, thus virtually eliminating the gradient from the center toward the edge. The entire areas that were sprigged had salts conductivity in excess of 30 mmhos/cm.

There was no sign whatsoever of any emerging plants of any of the three species. The extremely high level of salts is obviously beyond the tolerable level of all three species.

SUMMARY AND CONCLUSION

During the 2½ years of this project, a total of 371 accessions of 152 species of grasses, shrubs, forbs, and legumes have been planted in wet saline-alkaline soils as both seed and rhizome material. Of these, 31 have been foreign collections and 120 have been collections from native halophyte communities in Montana and Wyoming. The cooperative agreement and close working relationship with the USDA Soil Conservation Service has been of great benefit to this plant materials program. The nation-wide network of Plant Materials Centers and the National PMC have provided a continuous

supply of new plant materials from throughout the United States and the world. Several more foreign collections have been received and will be planted this fall (appendix table D).

The overall success of the materials being tested in the Initial Evaluation Plantings have been approximately 25%. Several accessions have developed favorably in very strongly salty soils (> 16 mmhos/cm). Some of the best accessions, developing from seed, have been as follows: M-1032 western wheatgrass, M-1030 slender wheatgrass, Altai wildrye, C-77 beardless wildrye, Wytana fourwing saltbush, Sawki Russian wildrye, M-935 Ruby Valley pointvetch, WY-573 plains bluegrass, M-997 Nuttall alkaligrass, WY-571 and NM-184 alkali sacaton, and PI-368851, Largo, and Alkar tall wheatgrass.

Both success and failure have been encountered in the sprigging program. The sprigging at the Bridger PMC has been very successful. An optimum time for sprigging has been determined (mid-September) and the 1976 replicated sprigging trials are revealing salt tolerance limits for the species being tested. Beardless wildrye has developed on all portions of the 8 to 30 mmhos/cm gradient. Creeping foxtail is exhibiting tolerance limits in the vicinity of 12 mmhos/cm, with western wheatgrass showing intermediate tolerance.

The sprigging at the field test sites has been relatively unsuccessful. The sprigging at Hardin was a failure, and at Powell only beardless wildrye exhibited any emergence. However, these two sites were quite severe, with high salts conductivity and

variable soil moisture conditions. The two new sites at Conrad and on the Highwood Bench are more representative of saline seeps resulting from the crop-fallow cropping system. By sprigging on a wide variety of sites, the limitations and economics of the sprigging technique of plant propagation may be determined.

APPENDIX TABLE A. The emergence, density, and vigor of 1975 IEP accessions that emerged from seed during the 1976 growing season.

Scientific Name	Accession	Initial Emergence	Density/5 meters 5/7	6/9	7/7	8/10	% Stand	Seedling Vigor 1/	Foliage Prod. 2/
Agropyron riparium	Sodar	5/7	2	2	2	2	1	5	7
Agropyron smithii	Barton	5/7	5	10	14	14	10	5	5
Agropyron smithii	P-727	5/7	1	1	2	2	1	7	7
Agropyron smithii	Rosana	5/7	10	14	16	18	5	5	5
Agropyron smithii	Mandan 456	5/7	5	6	8	8	5	4	5
Agropyron trachycaulum	Revenue	5/7	2	2	2	2	1	5	7
Elymus angustus	Mandan 1340	5/7	4	5	5	5	1	5	6
Elymus angustus	Altai	5/7	10	15	22	25	20	3	5
Elymus cinereus	M-382	5/7	2	2	2	2	1	6	7
Elymus giganteus	NB-328	4/24	97	135	150	160	80	1	1
Elymus cinereus	P-5797	4/24	16	12	10	10	5	6	5
Elymus giganteus	Volga	4/24	68	107	108	110	75	2	2
Elymus junceus	P-210	5/7	10	10	11	11	5	5	5
Elymus junceus	Sawki	4/24	134	132	103	103	60	2	3
Elymus junceus	Mayak	5/7	5	4	4	0	0	9	-
Oryzopsis hymenoides	P-15597	5/7	4	4	3	0	0	9	-
Oryzopsis hymenoides	Paloma	5/7	25	30	31	30	10	5	6
Atriplex gardneri	WY-548	5/7	1	1	1	1	1	5	5
Elymus junceus	PI-314665	5/7	25	30	32	38	20	2	2
Atriplex canescens	Wytana	5/7	9	9	9	9	40	1	2

1/ Seedling vigor on a scale 1 - 9 with 1 = excellent and 9 = dead.
2/ Foliage production on a scale 1 - 9 with 1 = excellent and 9 = dead.

APPENDIX TABLE B. The emergence, density, and vigor of seedlings in the 1976 Initial Evaluation Planting in wet-saline soils at the Bridger PMC.

Scientific Name	Accession	Initial Emergence	Density/5 meters 5/7	6/9	7/7	8/10	% Stand	Seedling Vigor 1/	Foliage Prod. 2/
Aeluropus litoralis	A-1655	7/7	0	0	3	8	5	5	7
Agropyron cristatum	CR-3	5/3	140	90	80	80	40	3	5
Agropyron dasystachyum	M-1041	4/24	170	124	96	80	25	5	7
Agropyron pseudorepens	M-1044	4/24	46	98	100	95	35	3	3
Agropyron pseudorepens	M-1045	5/7	38	106	90	92	30	3	3
Agropyron pungens	A-12235	-	-	-	-	-	-	-	-
Agropyron repens	M-1117	5/3	16	26	32	35	25	4	5
Agropyron smithii	M-998	5/3	8	47	44	49	30	3	2
Agropyron smithii	M-1032	5/7	21	104	105	110	75	2	2
Agropyron smithii	M-1050	5/3	60	104	102	105	60	2	4
Agropyron smithii	M-1057	5/7	12	75	59	61	40	5	7
Agropyron species	WY-567	5/7	43	16	16	16	10	7	6
Agropyron trachycaulum	M-1030	4/24	157	280	250	245	95	1	2
Agropyron trachycaulum	WY-574	5/3	180	220	177	180	80	5	5
Agropyron trachycaulum	WY-578	4/24	123	170	160	165	65	3	3
Agropyron trachycaulum	M-1054	4/24	195	165	170	172	65	1	1
Atriplex canescens	Wytana	6/2	0	1	1	0	0	9	-
Atriplex nuttallii	M-989	-	-	-	-	-	-	-	-
Alopecurus arundinaceus	Garrison	6/2	0	12	7	0	0	9	-
Beckmannia syzigachne	M-1043	5/7	5	2	3	0	0	9	-
Beckmannia syzigachne	M-1087	-	-	-	-	-	-	-	-
Buchloe dactyloides	SB-045	6/2	0	9	5	5	5	7	7
Calamagrostis canadensis	M-1066	-	-	-	-	-	-	-	-
Distichlis stricta	M-996	6/2	0	90	80	80	50	1	3
Elymus angustus	Altai	4/24	153	175	160	162	95	1	1
Elymus canadensis	M-995	5/3	60	27	18	15	5	6	7
Elymus canadensis	M-1035	5/3	10	27	12	5	5	7	7

1/ Seedling vigor on a scale 1-9 with 1=excellent and 9=dead.
2/ Foliage production on a scale 1-9 with 1=excellent and 9=dead.

APPENDIX TABLE B. The emergence, density, and vigor of seedlings in the 1976 Initial Evaluation Planting in wet-saline soils at the Bridger PMC. Continued.

Scientific Name	Accession	Initial Emergence	Density/5 meters 5/7	6/9	7/7	8/10	% Stand	Seedling Vigor	Foliage Prod.
Elymus junceus	Sawki	5/3	250	254	150	145	80	3	3
Elymus junceus	Mayak	4/24	135	85	62	65	40	5	6
Elymus junceus	BN-14844-63	4/24	324	272	165	170	75	4	4
Elymus salinus	C-28	-	-	-	-	-	-	-	-
Elymus triticoides	C-77	5/7	4	24	50	140	40	1	1
Elymus triticoides	P-2741	5/7	4	17	17	17	25	2	2
Eurotia lanata	M-966	-	-	-	-	-	-	-	-
Festuca arundinacea	Alta	5/3	180	133	85	90	15	5	6
Festuca arundinacea	Fawn	6/2	0	7	6	0	0	9	-
Festuca arundinacea	Goars	5/3	124	168	120	115	35	4	3
Festuca arundinacea	P-14944	5/3	180	152	97	90	20	6	6
Hilaria jamesii	A-12413	-	-	-	-	-	-	-	-
Iliamna grandiflora	NM-529	-	-	-	-	-	-	-	-
Muhlenbergia wrightii	A-8604-67	6/2	0	1	1	0	0	9	-
Oxytropis riparia	M-425	5/7	30	24	14	14	5	5	7
Oxytropis riparia	M-935	4/24	165	85	66	65	20	4	6
Panicum virgatum	M-1072	-	-	-	-	-	-	-	-
Glycyrrhiza lepidota	M-1075	6/2	0	1	8	3	5	7	7
Halimodendron halodendron	WY-549	5/7	1	10	15	15	5	5	6
Poa arida	NM-625	5/3	160	24	10	3	1	7	7
Poa arida	WY-573	4/24	385	220	150	140	25	4	3
Poa arida	WY-579	4/24	110	31	30	25	5	7	7
Poa arida	M-991	5/3	150	56	46	45	15	5	5
Poa arida	M-1037	5/3	155	106	98	90	20	6	5
Poa arida	M-1071	5/3	85	153	113	110	40	4	4
Poa glaucifolia	M-1049	-	-	-	-	-	-	-	-
Poa glaucifolia	M-1051	-	-	-	-	-	-	-	-
Poa glaucifolia	M-1068	-	-	-	-	-	-	-	-
Poa glaucifolia	M-1069	-	-	-	-	-	-	-	-

APPENDIX TABLE B. The emergence, density, and vigor of seedlings in the 1976 Initial Evaluation Planting in wet-saline soils at the Bridger PMC. Continued.

Scientific Name	Accession	Initial Emergence	Density/5 meters 5/7	6/9	7/7	8/10	% Stand	Seedling Vigor	Foliage Prod.
Poa species	M-1055	-	-	-	-	-	-	-	-
Puccinellia airoides	WY-564	4/24	1000+	1000+	1000+	1000+	90	1	1
Puccinellia airoides	WY-572	4/24	500	500	500	500	85	2	2
Puccinellia airoides	WY-580	4/24	1000+	1000+	1000+	1000+	95	3	4
Puccinellia airoides	M-41	4/24	1000+	1000+	1000+	1000+	80	3	3
Puccinellia airoides	M-990	4/24	1000+	1000+	1000+	1000+	90	2	2
Puccinellia airoides	M-917	5/3	500	500	500	500	50	4	3
Puccinellia airoides	M-997	4/24	450	1000+	1000+	1000+	95	1	3
Puccinellia airoides	M-1038	5/3	156	500	500	500	60	3	4
Puccinellia airoides	M-1018	4/24	600	600	600	600	60	5	5
Puccinellia distans	CSU-666	4/24	1000+	1000+	1000+	1000+	85	2	3
Sanguisorba minor	Al4173	5/3	30	0	0	0	0	9	-
Scirpus robustus	Comm.	6/2	0	6	5	0	0	9	-
Scirpus robustus	M-1086	-	-	-	-	-	-	-	-
Scirpus species	M-1040	5/7	1	0	0	0	0	9	-
Spartina gracilis	WY-566	5/7	2	6	6	8	5	6	7
Spartina gracilis	WY-570	5/7	10	53	50	50	15	4	5
Spartina gracilis	M-1023	5/7	4	26	18	18	10	5	7
Spartina gracilis	M-1036	-	-	-	-	-	-	-	-
Spartina gracilis	M-1039	5/7	13	20	12	12	5	6	7
Spartina pectinata	M-1031	6/2	0	2	1	1	1	8	8
Spartina pectinata	M-1056	-	-	-	-	-	-	-	-
Sporobolus airoides	NM-184	6/2	0	217	177	175	30	2	2
Sporobolus airoides	WY-51	6/2	0	5	8	8	5	6	6
Sporobolus airoides	WY-244	6/2	0	1	2	2	1	8	7
Sporobolus airoides	WY-571	6/2	0	112	125	130	20	4	4
Sporobolus airoides	WY-577	6/2	0	75	120	110	15	4	5
Sporobolus airoides	WY-581	6/2	0	20	42	45	10	5	6
Sporobolus airoides	M-21	6/2	0	21	12	12	5	7	7

APPENDIX TABLE B. The emergence, density, and vigor of seedlings in the 1976 Initial Evaluation Planting in wet-saline soils at the Bridger PMC. Continued.

Scientific Name	Accession	Initial Emergence	Density/5 meters 5/7	6/9	7/7	8/10	% Stand	Seedling Vigor	Foliage Prod.
Sporobolus airoides	M-992	5/7	1	0	1	0	0	9	-
Sporobolus airoides	M-1017	6/2	0	15	33	30	10	5	6
Sporobolus cryptandrus	M-898	-	-	-	-	-	-	-	-
Swainsonia salsula	WY-576	-	-	-	-	-	-	-	-
Swainsonia salsula	WY-569	-	-	-	-	-	-	-	-
Triglochin maritima	WY-565	-	-	-	-	-	-	-	-
Vicia americana	NDL-62	-	-	-	-	-	-	-	-
Vicia cracca	NDL-115	-	-	-	-	-	-	-	-
Vicia tenuifolia	NDL-82	-	-	-	-	-	-	-	-
Agropyron trachycaulum X *Hordeum jubatum*	M-1153	5/3	70	27	16	16	5	7	7

APPENDIX TABLE C. Accessions planted in a saline-alkaline soil at the Bridger Plant Materials Center on October 20, 1976 (1977 IEP).

Scientific Name	Accession	Source
* *Agropyron daystachyum*	WY-733	Sweetwater Co., WY
Agropyron elongatum	PI-358362	Latvia, USSR
* *Agropyron elongatum*	PI-315352	Leningrad, USSR
Agropyron elongatum	BN-20469-73	INRA, France
* *Agropyron pseudorepens*	M-1226	Musselshell Co., MT
* *Agropyron pungens*	A-12235	Los Lunas PMC
* *Agropyron smithii*	WY-742	Campbell Co., WY
* *Agropyron smithii molle*	WY-731	Sweetwater Co., WY
Agropyron species	WY-727	Fremont Co., WY
* *Agropyron* species	WY-741	Converse Co., WY
Agropyron trachycaulum	WY-724	Park Co., WY
Agrostis alba	WY-726	Fremont Co., WY
Atriplex halimus	PL-73-64	Pleasanton PMC
Deschampsia caespitosa	M-1066	Roosevelt Co., MT
* *Elymus hirtiflorus*	WY-735	Sweetwater Co., WY
Elymus hirtiflorus	WY-734	Sweetwater Co., WY
Elymus riparius	BN-20620-73	Canada
Elymus salinus	C-28	Los Lunas PMC
* *Elymus* species	WY-739	Albany Co., WY
Elymus triticoides	BN-206722-72	Versailles, France
* *Panicum virgatum*	SD-149	Forestburg, SD
Poa arida	WY-730	Fremont Co., WY
Poa compressa	WY-723	Park Co., WY
Poa compressa	WY-729	Fremont Co., WY
Poa juncifolia	M-1228	Carbon Co. MT
Poa juncifolia	M-1229	Lake Co., MT
Poa juncifolia	WY-722	Park Co., WY
Poa juncifolia	WY-738	Albany Co., WY
Puccinellia airoides	M-1180	Sanders Co., MT
Puccinellia airoides	WY-728	Fremont Co., WY
Puccinellia airoides	WY-736	Albany Co., WY
Puccinellia distans	PI-381008	Iran
Puccinellia distans	PI-381009	Iran
Puccinellia distans	PI-381010	Iran
Puccinellia distans	CSU-666	C.S.U.
Puccinellia fasciculata	BN-20784-73	Versailles, France
Puccinellia festucaeformis	BN-20785-73	Versailles, France
Puccinellia rupestris	BN-20787-73	Versailles, France
Spartina gracilis	M-1167	Golden Valley Co., MT
Spartina gracilis	M-1218	Golden Valley Co., MT
Spartina gracilis	WY-740	Converse Co., WY
Spartina gracilis	WY-732	Sweetwater Co., WY
Sporobolus airoides	WY-725	Fremont Co., WY
Sporobolus airoides	WY-737	Albany Co., WY

* Accessions which have emerged as of July 1, 1977.

APPENDIX TABLE C. Accessions planted in a saline-alkaline soil at the Bridger Plant Materials Center on October 20, 1976 (1977 IEP). Continued.

Scientific Name	Accession	Source
Sporobolus airoides	WY-743	Washakie Co., WY
Sporobolus airoides	PMT-1733	Sayer, OK
Sporobolus airoides	ND-264	Bismarck PMC
Sporobolus airoides	M-1181	Sanders Co., MT
Salvia pitheri	Nekan	Los Lunas PMC
Swainsonia salsula	WY-576	Fremont Co., WY
Swainsonia salsula	M-951	Jefferson Co., MT
Trifolium fragiferum	Salina	M.S.U.
Trifolium fragiferum	M-1235	Carbon Co., MT
Tripsacum dactyloides	PMK-24	Manhattan PMC
Vicia tenuifolia	P-15606	Brookings, SD

APPENDIX TABLE D. Foreign accessions received from Plant Materials Centers and Plant Introduction Stations to be planted in the fall of 1977.

Scientific Name	Accession	Source
National Plant Materials Center - Beltsville, Maryland		
Agropyron elongatum	PI-368850	Turkey
Elymus junceus	PI-314668	USSR
Elymus junceus	PI-316669	USSR
Elymus arenarius	PI-345979	Norway
Elymus arenarius	PI-358865	Belgium
Elymus arenarius	BN-20611-73	Chile
Plant Materials Center - Quicksand, Kentucky		
Trifolium fragiferum	PI-284267	France
Trifolium fragiferum	PI-284264	-
Trifolium fragiferum	PI-297984	Australia
Trifolium fragiferum	PI-231041	Turkey
Trifolium fragiferum	PI-227255B	Iran
Plant Introduction Station - Ames, Iowa		
Agrostis palustris	PI-204390	Turkey
Agrostis palustris	PI-221906	Afghanistan
Agrostis palustris	PI-235541	Sweden
Agrostis palustris	PI-235440	Switzerland
Agrostis palustris	PI-251945	Austria
Agrostis stolonifera	PI-222073	Afghanistan
Agrostis stolonifera	PI-230235	Iran
Agrostis stolonifera	PI-302902	Spain
Agrostis stolonifera	PI-318934	Spain
Agrostis stolonifera	PI-392337	USSR
Plant Introduction Station - Pullman, Washington		
Atriplex canescens	PI-330657	Israel
Atriplex hortensis	PI-310383	USSR
Atriplex leptocarpa	PI-342565	Australia
Atriplex muerlleri	PI-224963	S. Africa
Atriplex pseudocampanulata	PI-330666	Israel
Atriplex pseudocampanulata	PI-342567	Australia
Atriplex rosea	PI-330667	Israel
Atriplex semibaccata	PI-270313	Argentina
Atriplex semibaccata	PI-229488	S. Africa
Atriplex semibaccata	PI-316164	Australia
Atriplex semibaccata	PI-342571	Australia
Atriplex semibaccata	PI-342572	Australia
Atriplex suberecta	PI-368854	Australia

APPENDIX TABLE D. Foreign accessions received from Plant Materials Centers and Plant Introduction Stations to be planted in the fall of 1977. Continued.

Scientific Name	Accession	Source
Eurotia ceratoides	PI-345730	Spain
Kochia prostrata	PI-314929	USSR
Kochia prostrata	PI-330708	Iran
Kochia prostrata	PI-356817	USSR
Kochia prostrata	PI-356826	USSR
Kochia prostrata	PI-358941	USSR
Jardin Botanique De Nantes via MSU		
Salicornia dolichostachya	M-1295	France
Salicornia europaea	M-1296	France
Salicornia fruticosa	M-1297	France
Salicornia perennis	M-1298	France
Salicornia pusilla	M-1299	France
Salicornia ramosissima	M-1300	France
Suaeda maritima	M-1301	France
Suaeda vera	M-1302	France